Energy and Geopolitics, Volume 1

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Energy and Geopolitics, Volume 1:

Fundamentals

By

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Cambridge Scholars Publishing

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This book first published 2021

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN (10): 1-5275-7151-3
ISBN (13): 978-1-5275-7151-8

This book is dedicated to the memory of my parents. In the middle of the 20th century, they left Calabria (Italy) to immigrate to Charleroi (Belgium). My father passed from gathering oranges to a coal mine and my mother from olive gathering to washing a coal miner's clothes.

The great enemy of truth is often not the lie – deliberate, contrived and dishonest – but the myth – persistent, persuasive and unrealistic. Too often, we hold fast to the clichés of our forebears. We subject all facts to a prefabricated set of interpretations. We enjoy the comfort of opinion without the discomfort of thought.

– John F. Kennedy, Commencement Address at Yale University, 11 June 1962

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Acknowledgments

I would like to thank François Gauchenot and Loris Ajderian for their invaluable help in reading and correcting the manuscript.

DISCLAIMER

The author has never had any professional relationship with oil, gas or coal companies, nor has he had any private interest in them, and he has never requested or received funding from any environmentally related agency or organisation.

FOREWORD

Energy geopolitics have always had to adapt to the new conditions and market forces brought about by technological changes, but also to various social and geopolitical situations. We have now moved on from the energy geopolitics paradigm that started in 1973 with the first oil shock and that was then exacerbated by the Club of Rome's ideology. Leaving one paradigm and adapting to a radically different one is never an easy task. Historians with the benefit of hindsight can identify markers which characterise such turning points, but those who experience the changes directly will not necessarily recognise them as markers of a clear turning point. However, yes, the energy paradigm has indeed changed; we have left an era characterised by fear of energy scarcity for one in which energy is abundant.

The energy 'quarantine' of 1973–2013 is now over. The 40 years of wandering in the wilderness are finally behind us and we are entering the Promised Land, one flowing with abundant oil and gas. Accordingly, geopolitics, which is always the first to react to new realities, has already adapted. While most have not even started to perceive the change, geopolitics is now reshaping international policy. As always in international relations, those that can identify changes earlier than others enjoy a broad advantage; consequently, intelligence is fundamental. However, the old patterns of thought are still shaping the reactions of most non-energy actors, including national and local policymakers. Thus, those who have not understood the changes are still defending the pre-2014 vision of energy policy.

Energy policy emerged against the backdrop of this dated paradigm. Energy policy is a rather new development; until around 1990 there was no such thing as energy policy. The field emerged with the creation of the concept of sustainable development and its corollary, climate change, at the Rio Conference in June 1992 and with the signing of the Kyoto Protocol in December 1997. In short, it was created by Green's policymakers.

Before that, it was only necessary to ensure the supply of oil, and later natural gas, by engaging in diplomacy, i.e. geopolitical measures, and the need to ensure a constant supply of electricity by investing in power plants and electricity networks, an activity carried out by national companies or private companies strongly linked with the governments. Green policymakers introduced political decisions (choices which were not necessarily rational like production of oil products with farming products – see later) in a field that was until then only driven by rationality (market laws and technology). We will see that under free market conditions, engineers would have not made and adopted the many decisions and resolutions taken across the EU and other developed countries simply in the name of climate change. In developing countries, such irrational decisions were resisted because those countries could not afford to waste their scarce resources in favour of political expediency. This political conundrum is the one the world finds itself with.

However, there is a (missing) fact that needs to be integrated into (current) energy policy: people in developed countries today can be deemed as *Homo Energeticus*; they need and depend on energy for their daily lives and work. As the rest of the world's population aspires to a quality of life like that of the developed nations, the demand for energy is poised to grow. Economic growth in China, India, Africa and other non-OECD countries will enable some 3 billion people to join the middle class. It will be the largest collective increase in living standards in history. This will inevitably lead to an increased demand for food, travel, housing, schools, hospitals, water, sanitation, and businesses. It will mean better lives for billions of people. It will mean that the infinite jump in the improvement of the quality of life that OECD countries have experienced will become a reality for the rest of humanity.

This change requires more energy … significantly more energy. Contrary to mainstream ideas, the more energy than a society uses, the better it is for the environment. This is because a prosperous society is an efficient one. Richer people are much more careful about environmental issues, and they can better afford the development of solutions to deal with these issues. Karl Marx mocked Adam Smith's school of thought for its willingness to be efficient and to recycle. Yet, efficiency curbs growth in both energy demand and emissions. The net effect of these changes is best seen in the EU where the quality of life is improving while energy demand and polluting emissions have already fallen and will continue to fall further.

Today's energy situation is ushering in a new paradigm. It is not easy to grasp the new reality because we are living within the old paradigm. An external observer would see that immediately, but since we are actors within the old paradigm, our thinking is shaped by it and it is, therefore, not easy to discern the change. In life, nothing is eternal or linear. Moisés Naim – a well-known Venezuelan economist – shows in his book 'The End of Power'[1] that (1) institutions that were all-powerful in the past are now feeble as never before, (2) life has been revolutionised by abundance, (3) there has been a revolution in mentalities, and (4) mobility has greatly increased, all which has resulted in instability. There is no reason to think that what was true in 1973 will always remain so. No, the 'energy quarantine' – forty years of fears about oil scarcity and concerns that we will run out of resources – is now over. It is now time to build a new energy era for the good of all.

At this point, the reader may think that the new paradigm that I am referring to is the 'energy transition' to a low-carbon economy which is so popular now. The new geopolitical energy paradigm is one rather saturated by the abundant and apolitical supply of fossil fuel energy. Fossil fuels have never been as abundant as they are now. We will show how the quarantine imposed by OPEC in the early 1970s – i.e. the politicisation of fossil fuel energy – has ended thanks to technological advances and new maritime territories opened for exploration and production. The background to this transition is a broad panorama of global oil and gas resources being discovered and yet to be extracted. The shale gas and shale oil revolution are just beginning, and the implications for geopolitics are huge since it is reshuffling the cards at the global level of power.

Then, the usual question arises: if the world will be one with fossil fuels, what about the energy transition so desired, promoted, and even imposed? Oh yes, it will come about … one day! Nevertheless, not immediately as some hope and proclaim. The energy transition will emerge naturally without obligation when new technologies based on new science, now under investigation and technical development in leading laboratories, is sufficiently mature for large-scale implementation.

The problem of the energy transition to a low-carbon society is economy; the political will is at a maximum. Research technology and development have been widely supported over the last 40 years to the point that some mature technologies are now available. However, their competitiveness remains to be demonstrated. The current solutions for the energy transition to a low-carbon economy in Europe raise the huge and difficult question of cost. Now we have expensive options whereas the rest of the world is reaping the benefits of abundant and cheap fossil energy. Alone, a country or a corporation can do what it wants; in a global world, it is impossible to be right alone. Justifiably, businesses expect a level playing field for social and working conditions, and they also expect a level playing field for energy, i.e. for energy costs.

Nothing is stable forever in the world; not countries, nor boundaries, nor structures, nor institutions, and the list goes on. There is no reason for energy policy and energy geopolitics to remain static. One day when we abandon the use of fossil fuels, it will be because the new forms of renewable energy that scientists are developing in sophisticated research labs will have become economically viable, then we will have a new geopolitical energy landscape and new energy policies. Meanwhile, we live in an era of abundant fossil fuels that shape international diplomacy. While the public awaits an energy revolution, it does not realise that the counter-revolution has already been completed.

I realise that this statement right at the beginning of this book may surprise, shock, or even make the reader angry. I recognise that it is politically incorrect. However, it is a hard reality based on facts and numbers. Numbers are stubborn; therefore, I invite the reader to proceed with the demonstration.

Knowing that it will not be easy to convince the sceptical reader that this thesis is correct, I have tried to write this book as – I hope – a didactic demonstration, as if the writer was talking to the reader face-to-face. Consequently, the book is packed with a lot of facts, numbers and figures, and even anecdotes. Progress will inevitably be somewhat slow but pedagogic, explaining each new notion or concept as it is introduced, sometimes even lengthily with redundant examples and many cross-references. This is essential, however, to justify such a controversial position; nonetheless, it is a common one among energy specialists.

The reader might ask, 'if it is so common, why is it not better known?' Energy specialists in energy companies are paid by their shareholders to develop and raise the value of their companies; they are not remunerated to convince people – especially activists – that the world is full of cheap energy. Academics, on the other hand, receive funds for research that is decided by politically correct administrations and, therefore, their field of research is much oriented by policy decisions and not necessarily by facts. Today, if you do not introduce the word 'climate' in a research programme, it will be refused. Anyway, those that do not want to listen to energy specialists will dismiss them by saying, 'They are paid by oil companies,' which just translates to, 'they are not credible, it is better to rely on NGOs'.

This textbook is divided into three volumes. The first volume lays the foundations for an understanding of energy; this is essential to grasp the ideas presented in the second volume. As this demonstration goes against the grain, we start with a first part dedicated to the fundamentals of energy to understand what it is, to learn the essential truths of physics – based on universal laws that never change. Chapter 2 presents the fundamentals of data; without numbers, it is impossible to speak about energy. Chapter 3 is on the fundamentals of sustainable development, a political vision of society that heavily influences energy policy (but not energy geopolitics so much). Chapter 4 address the strong link between today energy policy and geopolitics and climate change issue. Volume 2 will then analyse all primary energy and some final energy. We will see how they are produced, their reserves, their markets, and the main actors.

In the third volume, all acquired pieces of knowledge will be brought into perspective to allow the reader to analyse present-day energy geopolitics.

The geopolitics of energy is closely linked to history. If we don't know what Winston Churchill did to establish the British oil industry in Iraq and Iran, we will find it difficult to believe in the real state the oil reserves of these countries. If we have never heard of the Quincy Pact agreed upon between President Franklin D. Roosevelt and King Ibn Saud on 14 February 1945, we are likely to misunderstand the present situation in Saudi Arabia. Overlooking the role of Muammar al-Gaddafi in the oil crisis of the 1970s would lead to a misunderstanding of the role of the Arabs and OPEC. Ignoring the role played by Boris Yeltsin in the post-Soviet era will make it difficult to understand Putin's policy today. Therefore, nearly every other page contains a reference to a historical event which puts the present situation into perspective. Occasionally, I illustrate this with some personal or semi-personal anecdotes.

The great economist John Maynard Keynes said, 'When the facts change, I change my mind. What do you do?' Even if some have claimed that Keynes did not make this statement, its meaning is so profound that it is often cited. It emphasises the need to stick to facts rather than wishful thinking or even ideology. Therefore, I opened this book with a quote from J. F. Kennedy. I sincerely hope that you will share my understanding of the changing world of energy and the associated geopolitical challenges, and that you may even change your mind on energy policy.

When the Apostle Paul spoke in the Areopagus in Athens, some sneered, but others said, 'We want to hear you again on this subject,' and some people believed. The outcome will probably be the same with at the end of this book.

1 ENERGY FUNDAMENTALS

Energy is a buzzword in our world, but it is much more complicated than it is usually assumed. In this chapter, we will lay out the foundations required to understand the rest of the book. After defining 'energy', we explain the difference between energy and power, how to measure energy, and how to establish the essential difference between primary energy and final energy. This will put us in a position to set out the three ways of using energy – heating, transportation, and electricity – showing that the physical characteristics of primary energy sources define their optimal uses.

Today we live in an era in which ubiquitous energy availability just seems normal. Children will find it normal to connect to an electrical outlet to charge a smartphone so they can play one of their favourite games. Electricity, gasoline stations, heating, and lighting are so banal that it is not at all surprising that some children believe that electricity just comes out of the wall. My parents' generation (born around 1910) grew up without the availability of energy. Thanks to energy, they were the only generation in history that saw the world change so profoundly.

1.1 What is energy?

In the first section, we will note that energy is, first, a matter of physics. The notions of physics outlined were developed during the 17th or 18th century throughout the Scientific Revolution by great scientists such as Galileo or Newton. They defined the theory, but unlike those born in the early 20th century, their daily lives did not change, nor did those of their children and grandchildren. It is only after the use of fossil energy became a reality, that world development adopted a different pace. Once humans domesticated the use of energy, their life was turned upside down or rather downside up.

1.1.1 First, energy is a physics concept

The etymology of energy, *energeia* in ancient Greek, means 'activity' or 'operation'. In the modern physical sciences, particularly mechanical physics, 'energy' refers to the capacity of a physical system to do something, to perform work. Energy is work and work is energy.

Energy is classified into two types, kinetic and potential. Kinetic energy refers to movement, whereas potential energy refers to stored energy. Energy can take on many forms, such as mechanical, thermal, electrical, chemical, and nuclear. Briefly, mechanical energy is about objects in motion; thermal, about the vibration of particles; electrical, about the flow of charged electrons; chemical, about the energy stored in the bonds between atoms; and nuclear, about the energy stored within the bounds of atoms. Some of these forms, like mechanical or electrical, can embody both kinetic and potential energy, whereas others like chemical and nuclear are exclusively potential energies. If the energy from these forms can be harnessed, it can be used to perform 'work'.

Work (W) is the integral of the scalar product of two vectors, a force (F) over displacement (du).

$$W = \int \vec{F}.\overrightarrow{du}$$

The work of a constant force F for a rectilinear displacement d in the direction of the force that caused the movement is the scalar product of the vectors F by d.

$$W = \vec{F}.\vec{d}$$

If the direction of the force is different of that of the movement, the value must be multiplied by the cosine of the angle ($cos\ \theta$) formed by the direction and the force. When you move any force, starting with your weight, you are performing work using energy.

$$W = F \cdot \cos\ \theta \cdot d$$

If you are climbing a staircase, for example, you move your mass, but because of the law of gravitation, your body is a weight, i.e. a force *F* (measured in Newtons) whose value is the result of your body mass *m* (measured in kilograms) multiplied by gravitational acceleration *g*[a].

$$W = m.g.d$$

The work you perform is calculated by multiplying your weight (in Newtons) by the distance (in metres towards the force). The unit that measures work, and therefore energy, is the Joule; one Joule being the work or the energy of a force of one Newton moved over one metre.

Moving a force, whether you climb a hill or use an elevator, or whether a rocket is launched in space, consumes energy. The larger the force and the greater the distance towards the force, the greater the work performed will be and, therefore, the greater the energy consumed will be. To this energy, we must also add the required energy for overcoming friction, i.e. overcoming the rolling and aerodynamic resistance varying with the square of the speed. Consequently, reducing energy consumption requires moving smaller forces over shorter distances. Thus, this explains why a large car needs more energy than a small one and why a long trip will require more energy than a short one. This might look trivial, but it has major consequences on energy policy particularly when it comes to energy saving.

Remaining motionless is the only way to limit energy consumption. Here we use the word 'limit' and not 'nullify', because, even when remaining motionless, energy is consumed. Our body, for example, consumes energy for pumping blood through our veins and moving air in and out of our lungs. Food

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[a] $g = 9.81\ m.s^{-2}$.

is not only a pleasure; it is foremost the energy that our body requires. Just as an idle automobile will eventually shut off if not refilled, our bodies will die if not provided with energy. No matter what you do, the blunt truths of physics teach us that it is impossible to do anything without energy. Because it is impossible to do the smallest work without energy, we should, therefore, try to be as efficient as possible. This, however, is also much more complicated than it sounds. We will later note that more people wanting to work, and to move, will have a dramatic consequence on the world's energy consumption.

1.1.1.1 Conservation of energy

Now, we need to introduce a fundamental notion called the first principle of thermodynamics. It asserts that energy is conserved; energy does not disappear and, therefore, that the sum of the various forms of energy is constant.

Energy contained in wood, for example, can be converted to heat, and wind energy can be transformed into electricity. In that sense, what we call 'renewable energy' is not renewable; a more correct name would be 'readily available' energy or 'flux energy' to oppose the other kinds of energy, like gas or petrol, that are considered 'stocked'. Renewable energy results from the action of the sun on water, air, and CO_2 to transform them into rain that will be accumulated in reservoirs to generate hydroelectricity, wind energy that would power wind turbines, or biomass that can be used as fuel. If the Earth were an isolated system, we would end up without energy. However, since we live in an open system, we receive an energy flux so long as the sun exists. The available energy in the world ultimately resulted from the gigantic 'big bang' blast that initiated the life of our universe; that energy can only be used and transformed from one form to another, but never created.

Let us take another example from daily life. When you want to prepare, say, spaghetti, the energy released by the combustion of natural gas in your stove is required for heating the water and cooking. Before the water temperature rises, the temperature of both the cooker and the pan will increase, although your goal may not necessarily be to heat them specifically. A part of the energy, furthermore, ends up in the form of water vapour on top of the pan. The total energy of the gas used is transformed into successive lost energy that heats the cooker, the pan, and the water, produces water vapour, and lastly causes the useful outcome which is to cook the pasta. Therefore, the energy used for your intended purpose is only a fraction of the total energy consumed.

All processes using energy are inefficient and some are inefficient, resulting in losses or huge losses of valuable energy. The dividend between useful output energy and total input energy is what we call 'efficiency' (symbolised by the Greek letter eta η). To transform heat into work or work into heat, thermal equipment requires a hot source and a cold source. The efficiency of such equipment is defined by the Carnot principle, named after Sadi Carnot, the famous French scientist and engineer who formalised this theory.

$$\eta = 1 - \frac{T_1}{T_2}$$

where T_1 and T_2 are the absolute temperatures[a] (in Kelvin) respectively to the cold source (usually the ambient air temperature) and the hot source.

As an example, a thermodynamic machine functioning at 20 °C environmental temperature and with a hot temperature of 500 °C will have a theoretical efficiency of

$$\eta = 1 - \frac{(20 + 273)}{(500 + 273)} = 0.62 \text{ or } 62\%$$

[a] Absolute temperature it the temperature above the zero absolute, i.e. above -273.15°C.

1.1.1.2 Degradation of energy

Unfortunately, there is another law of physics called the second law of thermodynamics, also known as the principle of degradation of energy that strongly upsets our energy situation. The second law states that the quality of energy degrades irreversibly, making it less available for work. We can observe that heat always goes from a hot object to a cold object and never the other way around. This loss is explained by entropy, a physics notion that measures the effectiveness of energy. When entropy increases, energy quality decreases. After all, energy is a quantity but also quality.

To illustrate, let us return to the kitchen. The energy of the hot water required for cooking the pasta will end up in the sink. According to the first principle of thermodynamics, the energy finishing in the sink is part of the total energy used, but it is useless energy because it is impossible to use it. It is impossible to transform this energy into more valuable energy[a]. The energy contained in the sink cannot have the same quality of energy which was contained in the natural gas. This is just impossible. It is impossible to do the same work with 100 litres of water at 1 °C that can be done with a litre of water at 100 °C, although they contain the same amount of energy.

Except for energy, everything on Earth, in theory, can be recycled (this is a new fashion – the circular economy). Unlike natural resources such as steel, aluminium, water, and stone, it is impossible to recover the energy from consumed energy, because at each manipulation it is constantly degraded to less noble energy. This peculiarity of energy causes the fear inherent in environmental movements that claim that in the future there will not be enough energy.

Among all energy types, electricity is more surprising. We will develop the topic in more depth in a later chapter, but now, it is

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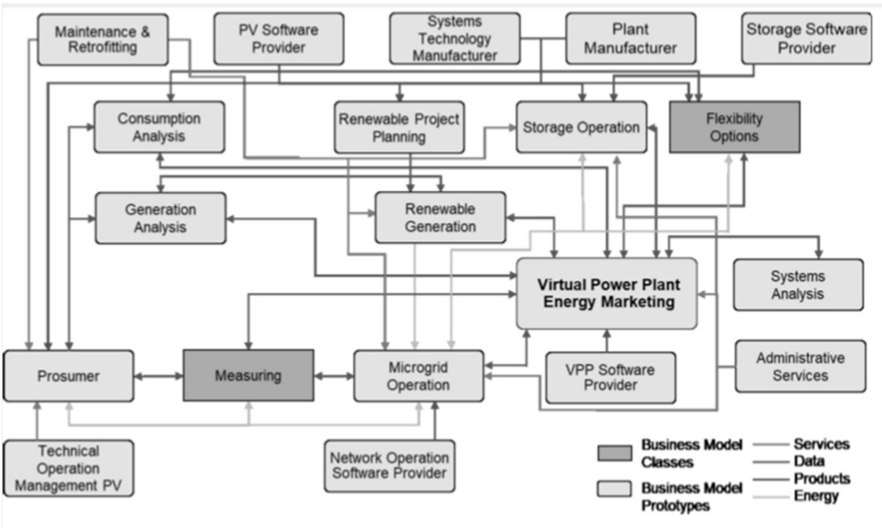
[a] To be precise, heat pumps can do that; however, they need energy to perform this action (see Volume 2).

enough to point out the strange nature of electricity: it can only be produced if it is used at the same moment – instantaneously, immediately – and, therefore, destroyed. It is impossible to produce electricity if it is not used and, therefore, destroyed at the same moment. We will see that this creates a huge difficulty for the generation of electricity. Of course, enthusiasts will answer that it is possible to store it. True, but for now only small quantities can be stored and, therefore, this does not solve energy policy.

Complex systems are often presented as feasible solutions to challenges in energy policy. Processes are integrated with other processes since, for some people, the more that processes are combined, the better the final result will be (Figure 1-1). The rationale behind this is probably that although people realise that there are efficiency losses at every step, they hope to recover them using a more complex system.

Figure 1-1 The complex German concept for its energy transition



One recent example is the idea of producing artificial natural gas. Some claim that an excess of electricity produced by wind energy could be used to produce hydrogen by water electrolysis.

This 'free' hydrogen would react with the CO_2 emitted by a gas-fired power plant, producing natural gas according to the Sabatier reaction. It seems like a miracle … free wind energy reacting with free fumes to produce valuable natural gas!

Who would be against such a nice presentation? He who knows how to calculate! Let us consider a process with the efficiency of 80%, which is an efficient process. If you introduce 100 units of energy, you will get only 80 units at the outlet. If this process is followed by another having the efficiency of 80%, the final efficiency will be:

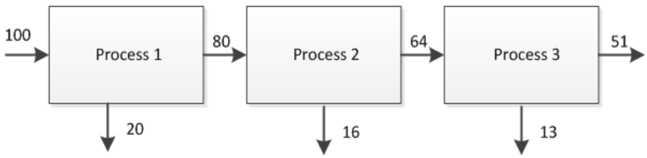
$$0.8 \times 0.8 = 0.64$$

With a three-step process, each having the efficiency of 80%, the total efficiency will be:

$$0.8 \times 0.8 \times 0.8 = 0.51$$

With just a succession of three efficient steps, half of the initial energy has disappeared. Clearly, energy does not like to be manipulated.

Figure 1-2 Inefficiency in multiple-step process



To sum up this subsection, the laws of physics explain that it is impossible to do anything without using energy, and that energy degrades constantly. It is therefore normal that we are in a huge impasse, the energy dilemma: humanity does need a lot of energy, but its use is inefficient and is also degrading. Accordingly, the less we manipulate energy, the less it degrades and the lower the losses. Burning wood in a power plant to transform water into vapour, then converting it into electricity used for heating the shower water is much more inefficient than heating the shower water directly with wood. Although it is inefficient, it is much more convenient. This demonstrates the energy dilemma.

1.1.2 Work is hard, but necessary for growth

Who has not sweat whilst working? Work is painful and, to escape it, people engineered solutions. They quickly realised that it was more comfortable to have work done by somebody else. First, they domesticated animals; oxen, donkeys, camels or horses were – and still are in some parts of the world – nothing more than energy substitutes for human work. They transform grass or hay into energy, i.e. they use renewable energy to work.

Box 1-1 Energy and slavery

With time – regrettably – violent people discovered that they could dominate others forcefully by obliging them to work in their benefit. A slave was considered by his owner nothing more than a cheap form of energy. At a time when there were no tractors or other machines, slaves were used as free energy, working on just a small portion of food. Thanks to great men's actions, like William Wilberforce, the abolition of slavery finally became a reality at the beginning of the 19th century. This English parliamentarian, as an Evangelical Protestant, fought all his life for this cause, and finally, shortly before his death, obtained the abolition of slavery in the UK. This stimulated the French abolitionist writer Victor Schoelcher to do this at the same time in the colonies.

However, humanitarian considerations were not the only reason to abolish slavery; another main driver was the emergence of the use of fossil fuels, facilitating this moral victory. It was easier and more convenient to use a tractor than a group of slaves; tractors are more obedient, more docile, more powerful, and more efficient. Slavery did not go alone; it covered a whole range of jobs such as a washerwoman, since it is much easier and even cheaper to do the laundry with a washing machine than having a person designated for this task. The development of energy supply eliminated slaves and house workers.

Today, thanks to fossil energy, we can easily clean our clothes, we can enjoy a hot shower, we can enjoy comfortable temperatures at home independently from the outside temperature, and we can move anywhere easily. I am not ignoring the scandalous working conditions of some workers or even children in some parts of the world. Unfortunately, today slaves are still used as a cheap energy source.

Indeed, we changed slavery by using 'virtual slaves', those who are replaced by energy. Jean-Marc Jancovici calculated that an average European is using the energy equivalent of about 400 workers or 'virtual slaves'[2]. He worked out that about 23 slaves would be required for producing our food, 237 to serve us at home and provide services, 145 for producing industrial goods which we enjoy, and 22 for transporting us. Criticising energy utilisation is easy, but once we have to decide which tens of slaves, we should eliminate to put our nice words and behaviour into practice, it proves to be difficult. For example, it is common to criticise people for using their cars rather than public transport, but I have never met someone eager to launder their clothes as done only 60 years ago by our grandparents. Jancovici's numbers show that it is precisely for our comfort, and in our homes, that we use the larger part of energy, not in transport. Environmentalists would have been wiser to criticise washing machines and refrigerators rather than promoting cycling.

In the past, the unit of power was the horsepower (HP), equivalent to 736 watts (we will come back to this in a few paragraphs). Since the power of a man is around 100 watts, a horse force is the equivalent of 7.36 men. According to the last